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A revision of *Tetrastigma* (Miq.) Planch. (Vitaceae) in Sarawak, Borneo

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Abstract: A revision of the genus *Tetrastigma* (Miq.) Planch. in Sarawak is presented. A total of 11 *Tetrastigma* species in Sarawak are recorded namely *T. brunneum* Merrill, *T. dichotomum* (Blume) Planch., *T. diepenhorstii* (Miq.) Latiff, *T. dubium* (Laws.) Planch., *T. glabratum* (Blume) Planch., *T. hookeri* (Lawson) Planch., *T. megacarpum* Latiff, *T. papillosum* (Blume) Planch., *T. pedunculare* (Wall. ex Laws.) Planch., *T. rafflesiae* (Miq.) Planch., and *T. tetragynum* Planch. Morphological descriptions are given for each taxon, as well as a key for identification. A general discussion on the growth habits and morphology of stem, inflorescence, flowers, fruits and seeds is also given.

Key words: distribution, morphological description, taxonomic key, *Tetrastigma* sect. *Carinata*, *Tetrastigma* sect. *Tetrastigma*

INTRODUCTION

The genus *Tetrastigma* (Miq.) Planch. is one of the 14 genera (about 95 species) of the grape family, Vitaceae (Chen et al. 2011; Latiff 1983; Nais 2001) and is typified by the species *Tetrastigma lanceolarium* (Roxb.) Planch. described from India. It is distributed in the Asian tropics, ranging from India to China, across Southeast Asia, eastward towards Fiji and extending towards subtropics Australia (Chen et al. 2011). *Tetrastigma* is characterised by unbranched to digitately branched tendrils, dioecious sexual system, and 4-lobed stigmas in pistillate flowers.

Latiff (1983) classified 12 *Tetrastigma* species in the Malay Peninsula into two sections based on fruit and seed morphology. *Tetrastigma* sect. *Tetrastigma* is characterized by its globose to ellipsoid, 1-2 seeded berries, globose or plano-convex seeds with chalazal knot extending ¾ of the seed length, and endosperm M-shaped in cross section. *Tetrastigma* sect. *Carinata* Latiff has pyriform (in dry state) and 3-or 4-seeded berries, convex-carinate seeds with the chalazal knot extending ½ along the length, and endosperm T-shaped in cross section (Latiff 2015; Latiff 1983). Li and Wu (1995) accepted these two sections, and recognized two subgenera, *Tetrastigma* subg. *Tetrastigma* and *Tetrastigma* subg. *Palmicirrata* C.L. Li. based on tendril morphology. Subgenus *Tetrastigma* possesses unbranched or 2-branched tendrils, elliptic, obovoid-elliptic, or obtriangular seeds with rugulose, smooth, or tuberculate seed surfaces. Subgenus *Tetrastigma* has three sections, namely *Tetrastigma* sect. *Tetrastigma*, sect. *Carinata*, and sect. *Orbicularia* C. L. Li. Subgenus *Palmicirrata* has digitately branched tendrils and flat globose seeds with reticulate surfaces.

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The description of *Tetrastigma* species were based on field observations and herbarium specimens available at BO (Research Centre for Biology, Cibinong), KEP (Forest Research Institute Malaysia), SAN (Forest Research Centre Sandakan), SAR (Department of Forestry, Kuching), SNP (Sabah Parks, Kota Kinabalu), SING (Singapore Botanic Garden, Singapore), UKMB (Universiti Kebangsaan Malaysia, Bangi) and Universiti Malaysia Sarawak (UNIMAS) Herbarium. Species descriptions were carried out following methods of Latiff (2015) with slight modifications. A total of 11 species of *Tetrastigma* were recorded. The species are *T. brunneum Merrill*, *T. dichotomum* (Bl.) Planch., *T. diepenhorstii* (Miq.) Latiff, *T. dubium* (Laws.) Planch., *T. glabratum* (Bl.) Planch., *T. hookeri* (Laws.) Planch., *T. megacarpum* Latiff, *T. papillosum* (Bl.) Planch., *T. pedunculare* (Wall. ex Laws.) Planch., *T. rafflesiae* (Miq.) Planch. and *T. tetragynum* Planch.

HABIT AND MORPHOLOGY

Growth habits. All species climb by means of tendrils that borne opposite the leaves on the long vegetative shoots. *Tetrastigma* in Sarawak have unbranched and branched tendrils. *Tetrastigma brunneum, T. dichotomum, T. diepenhorstii, T. papillosum*, and *T. pedunculare* have branched tendrils, while the others have unbranced tendrils except for *T. dubium* which has both type of tendrils on the same plant. During the observation in the field, tendrils in *Tetrastigma* were found to coil to any plant organs adjacent to them. Tendrils tend to coil on their own and onto other plant parts (such as petioles, stem, tendrils), and dried twigs. *Tetrastigma* species were found as large vines, their older stems were brown in colour, thick, woody, striate, and up to more than 15 m long. Young stems were observed creeping on the forest floor and on fallen trees. The older stems of *Tetrastigma* species were observed along river banks, near waterfalls and forest edges. This observation showed that *Tetrastigma* species proliferate in areas with high light availability (Schnitzer and Bongers 2002).

Stem. The stems are striate with some variations such as rounded in *T. diepenhorstii*, terete in *T. rafflesiae* and winged in *T. megacarpum*. The striate stems which are easily broken or cracked would provide a suitable niche for some parasitic plants namely *Rafflesia*, *Sapria* and *Rhizanthes* to obtain water, nutrient and protection (Haji Adam et al. 2013; Nais 2001). Lenticels are present on stems and rarely on petioles of *Tetrastigma*. Lenticels are oval to round in shape, light brown colour and scattered. Some of the lenticels are discrete or coalesced and are arranged in longitudinal or vertical rows.

Leaves. All species have compound leaves with leaflets ranging from three to seven. *Tetrastigma brunneum, T. dichotomum, T. diepenhorstii, T. dubium, T. glabratum, T. pedunculare* and *T. papillosum* are predominantly trifoliolate, rarely having 1-2-leaflets on the same stem. There are a few species that have 5-7-leaflets, which are *T. hookeri, T. megacarpum, T. rafflesiae and T. tetragynum*. However, *T. hookeri* collected from Tasik Biru, Bau was found to have 3-foliolate leaves and was reported to be very rare (Latiff 1983). Leaf size is an important diagnostic character for some *Tetrastigma* species. For instance, lateral leaflets of *T. dubium* are always smaller than the terminal leaflets. *Tetrastigma brunneum* has very small leaflets ranging from 5.0-10.0 cm long and 2.0-5.0 cm wide. In contrast, *T. megacarpum* has leaflets ranging from 17.5-18.0 cm long and 6.5-9.5 cm wide.

Inflorescences. The inflorescence in all species is pedunculate and the peduncles are easily observed. The peduncle length differs between species. For example, *T. dichotomum* has longer peduncles than *T. rafflesiae*, 4.7-5.4 cm and 0.5-2 cm, respectively. The inflorescence is a cyme which is of different types: corymbose in *T. papillosum*, umbellate in *T. diepenhorstii*, and dichotomous in others.

Flowers. *Tetrastigma* is dioecious, having pistillate and staminate flowers in different individuals. The flowers are 4-merous but sometimes 5-merous. The calyx is small and subcupuliform. The petals are membranous; glabrous on the outside or slightly pubescent and strongly reflexed in the buds. In this study, flowers of *T. dubium* collected from Borneo Highland resort have pubescent on the outside of the petals. The production of inflorescence's pubescence may probably act as an effective insulator to protect the flower during daytime by maintaining the flower temperature (Miller 1986).

The stigma in pistillate flower is 4-lobed but entire in staminate flowers. The four narrow segments of the stigmas are orientated either vertically as in *T. pedunculare* or horizontally as in *T. dubium*. In other species, the four segments are not very conspicuous because the stigmatic surface is densely covered with simple multicellular hairs or cilia. The ciliate stigma could be an adaptive feature to ensure better deposition of pollen grains in dioecious plants like *Tetrastigma* (Latiff 1983). *Tetrastigma* is the only genus that staminodes are present in the pistillate flowers. In shape and position, staminodes are suggestive of reduced stamens (Latiff 1983).

Fruits. The fruits in all species are berries. The degree of pulpiness varies from species to species. The berries of *T. hookeri* are very pulpy; however, it is moderately pulpy in *T. dubium*. Variations in size and shape of the berries is useful for species identification in the genus *Tetrastigma* (Latiff 1983). In term of size, *T. hookeri* has the largest berries, about 3.5 cm in diameter while T. pedunculare has the smallest berries about 0.7 cm in diameter. *Tetrastigma diepenhorstii* has oblong-shaped berries while *T. rafflesiae* has globose-shaped berries in fresh state.

Seeds. Seed shape can be used to classify *Tetrastigma* species into two sections based on Latiff (1983 and 2015) with slight modifications. The two sections are section Tetrastigma, where the seed shape is globose to ellipsoid to plano-convex, and section *Carinata*, where the seed shape is convex carinate. Table 1 shows the classification of Tetrastigma species in Sarawak into two sections based on the seed shape.

Table 1. Classification of *Tetrastigma* species in Sarawak into sect. *Tetrastigma* and sect. *Carinata* based on seed shape

Section *Tetrastigma* (Seed shape: Plano-convex)	Section *Carinata* (Seed shape: Convex-carinate)
T. brunneum *T. dichotomum* *T. diepenhorstii* *T. dubium* *T. glabratum* *T. hookeri* *T. rafflesiae* *T. tetragynum* *T. megacarpum*	*T. pedunculare* *T. papillosum*

Host-parasite relationship. *Rafflesia tuan-mudae* Becc., a holoparasitic plant endemic to Sarawak is a parasite on two *Tetrastigma* species namely *T. rafflesiae* and *T. diepenhorstii* (Wan Zakaria et al. 2016). *Rafflesia* seeds germinated in between the striate stems of the *Tetrastigma* (Nais 2001). The strap-like stems which are easily broken or cracked in most *Tetrastigma* species provide a suitable niche for the Rafflesia seeds to grow (Nais 2001).

Habitat and ecology. *Tetrastigma* species grow well in mixed dipterocarp, montane, limestone, kerangas and secondary forests. In this study, *T. diepenhorstii* was found growing on all types of forest and *T. dubium* however, was found growing mostly on limestone forest. In general, all *Tetrastigma* species in Sarawak can inhabit both low and high elevation. *Tetrastigma dubium*, *T. glabratum, T. hookeri, T. megacarpum* and *T. rafflesiae* are found at low elevation below 1000 m while the remaining species are found at both low and high elevations. Tetrastigma brunneum however is the only species that can be found at high elevation between 1260 to 1420 m above sea level. *Tetrastigma* species can be found across the state. However, some *Tetrastigma* species are more localized to a particular area such as Kuching division as shown in *T. dubium* and Miri division as shown in *T. brunneum*.

Knowledge on the pollination of *Tetrastigma* is important. Yet, there is very little or no information on pollination of *Tetrastigma* in Sarawak at this time. However, during field sampling at Mount Pueh in 2015, some Asiatic honey bees (Apidae) were observed on female flowers of *T. diepenhorstii*. This observation therefore would suggest that honey bees as the potential pollinator for *T. diepenhorstii*.

***Tetrastigma* (Miq.) Planch.**

In DC. Monog. Phan. 5 (1887) 423; Suessength in Engler and Prantl, Nat. Pfl. Fam. 20d (1953) 318; Backer and Bakhuizen v. d. Brink, Fl. Java 2 (1965) 88. Vitis sect. *Tetrastigma* Miquel, Ann. Mus. Bot. Lugd.-Bat. 1 (1862) 72; King, J. As. Soc. Beng. 65, 2 (1896) 386; Ridley, Fl. Mal. Penin. 1 (1922) 470 – Type: *T. lanceolarium* (Roxb.) Planch.
Vitis sect. *Tetrastigma* Miq., Ann. Mus. Lugd. Bat. 1 (1860) 72; King, J. As. Soc. Beng. 65, 2 (1896) 386; Backer, Fl. Bat. (1907) 319; Ridley, Fl. Mal. Penin. 1 (1922) 470.

Large, woody, dioecious vines. Stem terete or flattened, conspicuously lenticellate. Leaves simple or/and compound. Tendrils simple, leaf-opposed, not ending with an adhesive disc. Inflorescence axillary and pedunculate, a cyme, the umbellate cyme, corymbose or dichotomous. Flowers 4(5)-merous; unisexual, pedicellate. Calyx subcupuliform to disciform. Petals reflexed in mature flowers. Disc adnate to ovary in pistillate flowers, 4-lobed, free in staminate flowers. Filaments filiform. Anthers orbicular to ovate-oblong. Staminodes filiform. Style terete, short. Stigma minute and entire in staminate flowers, large, 4-lobed, and ciliolate in pistillate flowers. Berries pyriform to globose. Seeds with dorsal side convex and ridged or furrowed, ventral side convex or carinate; endosperm T- or M-shaped in cross-section.

Distribution. About 95 species, in tropical and subtropical Asia and Australia.

Ecology. Occurs in all kinds of habitat from sea-level to high mountains.

Key to *Tetrasigma* species in Sarawak

1a. Stems with corky, sharp excresences; tendrils furcate, some leaf-opposed; terminal leaflets elliptic to obovate; leaflets glabrous beneath; inflorescence corymbose cyme; berries red, globose, 3-seeded, testa ridged..... **8. *T. papillosum***
1b. Stems without corky excresenes……..**2**

2a.Leaflets pedate ……..**3**
2b.Leaflets digitate...…….**5**

3a. Secondary venation raised and prominent; inflorescence dichotomous cyme; berries globose, 1-seeded, ellipsoid …….....***6. T. hookeri***
3b. Secondary venation not raised and not prominent……..……..**4**

4a. Leaflets chartaceous; berries 0.7 x 0.5 cm; 1-seeded, ellipsoid when dry……. .....***11. T. tetragynum***
4b.Leaflets coriaceous; berries 1.5 x 2.2 cm, 1- to 2-seeded, oblong when dry ……..…..***10. T. rafflesiae***

5a. Midrib on adaxial and abaxial surfaces covered with hairs……..……...… **6**
5b. Midrib on adaxial and abaxial always glabrous……..……..……**7**
6a. Lateral leaflets always smaller than terminal leaflets; leaf shape elliptic to obovate; inflorescence axillary; peduncles 2.5-6 cm long…..……... ***4. T. dubium***
6b. Lateral leaflets not smaller than terminal leaflets; leaf shape broadly elliptic to obovate; inflorescence axillary; peduncles 1.2-2 cm long ….…… ..***9. T. pedunculare***

7a. Leaf size large, more than 9 cm long…… **8**
7b. Leaf size small, not more than 9 cm long……... **10**

8a. Leaflets 5-foliolate, rarely 3-4 foliolate; digitate; glabrous on both sides; tendrils simple; inflorescence umbellate cyme; berries globose when fresh; seeds oblong, plano-convex, 4-seeded……..……***7. T. megacarpum***
8b. Leaflets 3-foliolate, rarely 1-2-foliolate…….....9

9a. Secondary venation prominent; berries globose, ca. 1.5 cm long x 1.3 cm wide, 1-3-seeded……***5. T. glabratum***
9b. Secondary venation not prominent; berries oblong, ca. 0.8 cm long x 0.5 cm wide, 1-seeded…… ...…***3. T. diepenhorstii***

10a. Secondary venation prominent; inflorescence axillary, 4.7-5.4 cm long, cyme dichotomous……..***2. T. dichotomum***
10b. Secondary venation not prominent; inflorescence axillary, 8 cm long, corymbose-paniculate ……..……..……***1. T. brunneum***

ENUMERATION OF SPECIES

1. *Tetrastigma brunneum* Merrill

Tetrastigma brunneum Merr., Philip. J. Sci. 7, 2 (1912) 85 et Enum. Philip. Fl. Plt. 3 (1923) 3; Suesseng. in Engler & Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 324 - Type: Philippines, Luzon, Bontoc, Vanoverbergh 795. Tetrastigma laxum Merr., Philip. J. Sci. 11, 3 (1916) 140 et Enum. Philip. Fl. Plt. 3 (1923) 4; Suesseng. in Engler & Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 324 - Type: Philippines, Luzon, Lamao river, Borden 2495. Stem hollow, glabrous, longitudinally striate, 1.2-3.2 mm across, lenticels few, not prominent. Tendrils furcate, some leaf-opposed, 5.3-10.0 cm or longer, 0.2-0.4 cm across, white in color, long and straight hairs. Leaves digitate 3-5 foliate, rarely 2-foliate, coriaceous, glabrous, the petioles 1.5-5.0 cm long, 0.1-0.2 cm across, swollen at petiole base with brown growth ring, lenticels not prominent, longitudinally striate, the stipules triangular, 0.2 cm long, 0.2 cm wide at base, not persistent, and terminal leaflets ovate, oblong-ovate, or subelliptic, 5.0-10.0 cm long, 2.0-5.0 cm wide, firmly coriaceous, glabrous on both sides, the apex acutely acuminate, the base rounded or acute, the margin distantly crenate-serrate, the teeth rather prominent, often apiculate, veins 5-6 pairs, less conspicuous above and below, midrib becoming flatten above and below, secondary venation not prominent, the petiolules about 1.5 cm long, lateral leaflets slightly smaller than the terminal leaflets, the apex, base, margin, and veins as in terminal leaflets, thepetiolules 0.4-0.8 cm long. Inflorescence axillary, peduncled, 3.5-8.5 cm long, corymbose-paniculate, many flowered, often forming terminal or subterminal more or less leafy panicles. Male flowers calyx shallowly cup-shaped, truncate, about 1 mm diameter; petals 4, free, oblong, 1.8 to 2 mm long, obtuse, cucullate at the apex inside; filaments about 1 mm long, inserted under the brand disk, anthers 0.5 mm long, broader than long; disk prominent, obscurely 4-angled or lobed. Female flowers calyx funnel shaped, truncate, 1.2 mm in diameter. Petals as in male flowers. Stamoniodes slender, 1 mm long, slightly dilated at the apex. Ovary cylindric-ovoid, truncate, glabrous, 1.2 mm long; stigma sessile, disk-like, not at all or very obscurely lobed, 0.7 mm in diameter. Fruit obovoid to oblong-obovoid, apparently some-what fleshy, 1- to 2-seeded, 0.8 x 0.4 cm, plano-convex.

Distribution. Borneo (Sarawak, Sabah), The Philippines

Habitat. This species inhabits mostly on mixed dipterocarp to submontane forest at elevtion from 1260 m to 1420 m a.s.l.

Vernacular name. Akar ruran (Iban)

Notes. The species can climb up to 5 m high. The inflorescences are in green and cream.

Selected specimens examined. BORNEO. Sarawak, Miri, Mt. Mulu National Park, Camp 3, Submontane forest, *WNF 118*, 1300 m, *WNF 114*, *WNF 116*, 1368 m; *WNF 115*, 1368 m, 30 August 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, Submontane forest, *WNF 113*, 1416 m; *WNF 117*, 1359 m, W. N. Fatiha & S. N. Aishah, 10 May 2015 (UNIMAS Herb.); Miri, Mt. Mulu, Near camp 3, Submontane forest, *WNF 29*, 1261 m, 12 May 2015, W. N. Fatiha & S.N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, Submontane forest, *WNF 112*, 1368 m, 1 September 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.).

2. *Tetrastigma dichotomum* (Blume) Planch.

in DC., Monog. Phan. 5 (1887) 441; Gagnep., Not. Syst. 1 (1910) 322; Suessenguth in Engler and Prantl, Nat. Pfl. Fam. 20 d (1953) 323; Backer and Bakhuizen v.d. Brink, Fl. Java 2 (1965) 89; Latiff, Gard. Bull. Sing. 36, 2 (1983) Lectotype: Indonesia, Java, n. loc, Blume s.n. (L!). *Cissus dichotoma* Blume, Bi jdr. 1 (1825) 186; Miquel, Fl. Nederlandsch Indie, 1 (1859) 603; George Don, Gen. Hist. 1 (1831) 693; Junghuhn, F. W. (1850) 449; Junghuhn, F. W. & Hasskarl, J. K. 1 (1857) 325; Wagner, H., Malerische Botanik, 1-2 (1861) 11- Isotype: Indonesia, Java, Blume s.n. (NYBG). *Vitis dichotoma* (Blume) Miq., Fl. Ind. Bat. Suppl. 1 (1860-61) 601 et Ann. Mus. Bot. Lugd. Bat. 1 (1863-64) 73; Backer, Schoolfl. Java (1911) 252 – Type: Indonesia, Java, Hasskarl 526 (L).
Tetrastigma pergamaceum (Bl.) Planch. in DC. Monog. Phan. 5, 2 (1887) 431; Schumann, Fl. Kais. Wilhelmsl. (1889) 72; Warburg, Bot. Jahrb. XIII (1891) 370; Schumann and Lauterbach, Fl. Deutsch. Schutzgeb. Sudsee (1900) 430; Lauterbach, Bot. Jahrb. 59 (1925) 515 – Type: Indonesia, Java, Semarang, Blume s.n. (Burmann Herb.). *Cissus pergamacea* Blume, Bijdr. 1 (1825) 183 – Type: Java, s.l., Blume s.n. (L). *Vitis pergamacea* (Blume) Miq., Fl. Ind. Bat. 1 (1860-61) 601 et Ann. Mus. Bot. Lugd. Bat. 1 (1863-64) 73; Backer, Schoolfl. Java (1911) 252 – Type: Indonesia, Sumatra, s. n. (L). *Tetrastigma articulatum* (Miq.) Planch. in DC., Monog. Phan. 5, 2 (1887) 439; Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 325. *Vitis articulata* Miq., Ann. Mus. Bot. Lugd. Bat. 1 (1863-64) 76 – Type: Borneo, Kalimantan, Korthals s.n. in xi/63 (L). *Vitis coffeaecarpa* Teysm. & Binn. In Bulletin de L'Institut Botanique de buitenzorg. 12-21(1902-1908) 39. *Tetrastigma enervium* Ridl., Bull. Misc. Inform. Kew. 10 (1931) 498; Suesseng. in Engler & Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 325. Tetrastigma havilandii Ridl., Bull. Misc. Inform. Kew. 10 (1931) 497; Suesseng. in Engler & Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 320 – Type: Borneo, Sarawak, Kuching, Haviland 2242. *Cayratia simplicifolia* (Merr.) Quisumb., Philipp. J. Sci. 76, 3 (1944) 202; Suesseng., Mitt. Bot. Staatssaml. Munchen 1 (1953) 353; Jahrg. 44, 1 (1915) 257. *Columella simplicifolia* Merr., Philip. J. Bot. 11, 3 (1916) 135; Mitt. Bot. Staatssamml. Munch., 1 (1950-1954) 353 – Type: Philippines, Leyte, Ramos Bur. Sci. 15308.

Stem in brown to black, 0.8-1.2 cm in diameter, lenticellate, hollow, climb up to 1-2 meters high. Tendrils furcate, some leaf-opposed, 4 cm or longer, 0.4-0.6 mm across. Leaves simple or 3-foliate, rarely 2-foliate, coriaceous, glabrous; simple leaves 8.7-10.2 x 3.4-4.8 cm, elliptical, acuminate, obtuse at base, serrate, the petiole 2.7-6.1 cm; compound leaves with terminal leaflets 3.2-9.4 x 2.5-4.4 cm, elliptical to lanceolate, acuminate, decurrent at base, serrate, veins 4-6 pairs, glabrous, less conspicuous above, prominent below, the petiolule 1.5-2.1 cm, the stipule triangular, 0.2-0.4 cm long, 0.2-0.4 cm, not persistent; lateral leaflets 4.8-9.7 x 2.1-5.5 cm, the outline, apex, base, margin, and vein as in terminal leaflets, the petiolule 0.8-1.0 cm. Inflorescence green, axillary, peduncled, black, 4.7-5.4 cm, cyme dichotomus. Staminate flowers obovoid, filament white, anther yellow. Pistillate flowers calyx green, petals 4-merous, white, oblong, the staminode c. 0.6 mm, the stigma-lobe rounded. Berries green unripe, red when ripe, 1.2-2.2 cm long x 0.6-1.0 cm wide, ellipsoid to plano-convex when dry, usually 1-seeded; seed 1.2 x 0.5 cm, oblong, the endosperm M-shaped in cross-section.

Distribution. Borneo (Sarawak, Sabah), Java, Sumatra, Peninsular Malaysia

Habitat. On the fringes of hill dipterocarp forests and submontane forests. Some specimens from Sarawak are also reported to inhabit kerangas and peat swamp forests. In Sarawak, this species is found at elevation between 200 m to 2297 m above sea level. In Sabah, some specimens are reported to inhabit upper montane forest and mossy forest.

Vernacular name. Wa cheri (Kelabit Baram, Sarawak)

Notes. This species is found to be associated with other plant from Sapotaceae family. The root morphology of this species is allorhizic root system.

Selected specimens examined. BORNEO. Sarawak, Miri, Along trail from camp 3 to camp 1, Mt. Mulu National Park, *WNF 28*, 1487 m, 10 May 2015, W.N.Fatiha & S.N.Aishah (UNIMAS Herb.); Miri, Summit ridge of Mt. Mulu, along the way to summit from camp 4, *WNF 30*, 2297 m; *WNF 31*, 2278 m, 8 May 2015, W. N. Fatiha & S.N.Aishah (UNIMAS Herb.); Miri, Summit ridge of Mt. Mulu, along the way to camp 4 from camp 3, *WNF 176*, 1300 m, 30 August 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, 4th division, Camp 3, Gunung Mulu, Mulu National Park, Submontane forest, *S. 58248*, 1320 m, 8 March 1990, Yii P. C. & Abu Talib (KEP, K, L, SAN); Bau, 1 st division, Bt. Buan, Buso, Limestone cliff, *S. 37465*, 200 ft., 27 May 1975, James Mamit (SAN, KEP, L, K); Limbang, Summit ridge of Mt. Murud, helipad, Near church, *S. 80094*, 2100 m, 22 March 1999, Julaihi et al. (SAR); Sri Aman, Sungei Senkeli, Kpg. Gua, 99th Miles, 2nd Division, Kerangas forest, *S. 42741*, 200 m, 6 September 1980, Ilias Paie (SAR); Lawas, Kuala Lawas, *S. 11088*, Jun 1958, J. A. R. Anderson (SAR); Baram, Swamp forest, *S. 3287*, 10 Oct 1955, J. A. R. Anderson (SAR); Baram, 4th division, Kelabit highland, Secondary kerangas forest, *S. 35350*, 3 500 ft., 6 November 1974, Paul Chai (SAR, K, L); Saribas, Tanjong Keranji, Secondary peat swamp forest (P. C. 3) after logging, *S. 19693*, 10 May 1966, J. A. R. Anderson (SAR); Baram, Gunung Api, *S. 4725*, 3900 m, 12 July 1961, J. A. R. Anderson (SAR, K, L); Belaga, 7th Division, Sg. Linau, Bkt. Damai, on top of a ridge on the way to Bkt. Dema, dry soil, *S. 39849*, 1200 m, 28 August 1978, Bernard Lee (SAR, L); Baram, 4th Division, Pa Ukat, along path to Pa Umor, Kelabit Highland, Kerangas forest on more fertile soil, *S. 35404*, 8 November 1974, Paul Chai (SAR, SAN, L, K, MO); 2nd Summit of Gunung Api, View point of pinnacles, Submontane limestone summit forest, S. 84442, 1140 m, 15 August 2000, Julaihi et al. (SAR, SAN, KEP, K,L); Gunung Api, Gunung Mulu National Park, Limestone forest, *S. 84447*, 1100 m, 23 August 2000, Julaihi et al. (SAR, KEP); Murud II, Mountain forest, *S. 88386*, 2100 m, 28 April 2002, Yahud, Mahmud et al. (SAR, SAN, KEP, K,L); Miri, 4th Division, Gunung Api, Mulu National Park, Limestone forest, *S. 58819*, 890-1170 m, 29 Mac 1990, Yii P. C. & Abu Talib (SAR, SAN, KEP, K, L); Kapit, Sg. Khabor, Batu Laga, Kerangas forest, *S. 48116*, 700 m, 1 September 1984, Abg. Mohtar (SAR). Lawas,Bukit Tebunan, Ulu Trusan, 5th Division, *S. 52555*, 900 m, 12 May 1986; Bernard Lee (SAR, SAN, K, L); Lawas, Bukit Tebunan, Ulu Trusan, 5th Division, *S. 52493*, 1450 m, 9 May 1986, Bernard Lee (SAR, KEP, K, L).

3. *Tetrastigma diepenhorstii* (Miq.) Latiff

Folia malaysiana 2(3(2001): 185. *Vitis diepenhorstii* Miq. Fl. Ind. Bat. Supp. 1 (1860-61) 515 – Type: Indonesia, Sumatra, Priaman, Diepenhorst s.n. (Iso. L). *Tetrastigma trifoliolatum* Merr. Philip. J. Sci. 9, 4 (1914) 370 et Enum. Philip. Fl. Plt. 3 (1923) 5; Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 326; Flora Malesiana 1(13 (1997) 26 – Type: The Philippines, Leyte, C.A. Wenzel 544.

Large liane, glabrous. Stem rounded, hollow, longitudinally striate, 1.5-1.9 cm across, lenticellate, prominent, raised. Tendrils furcate, some leaf-opposed, 2.8-26.0 cm or longer, 0.2 cm across, glabrous. Leaves 3-foliate, rarely 1-2-foliate, chartaceous, glabrous, the petioles 14-28 cm long, 0.2-0.4 cm thick, lenticellate, striate, the stipules triangular, 0.3-0.7 cm long, 0.4-0.5 cm wide at base; terminal leaflets lanceolate to elliptic to slightly obovate, 6.9-23.0 cm long, 3.1-10.6 cm wide, glabrous on both sides, the apex acuminate, the base acute, the margin serrate, primary venation 6-10 pairs, less conspicuous above, prominent below, midrib becoming flatten above and below, secondary venation obsolete, the petiolules 5.5-6.0 cm long; lateral leaflets 13.2-14.0 cm long, 3.0-3.5 cm wide, the apex, base, margin, primary and secondary venation as in terminal leaflets, the petiolules 0.7-1.3 cm long, 0.2-0.3 cm across. Inflorescence axillary, peduncled, umbellate, 1.0-2.5 cm long. Berries small, oblong, reddish when ripe, 0.7-0.8 cm long, 0.4-0.5 cm wide, 1-seeded, seed

oblong, convex carinate, 0.8 x 0.5 cm, chalazal groove prominent, chalazal knot extending full way of the seed length.

Distribution. Borneo (Sarawak, Sabah), Sumatra, The Philippines

Habitat. The species can be found mostly in lowland mixed dipterocarp, limestone to submontane forest at altitude ranging from 30 to 1100 m above sea level. It climbs up to 15 m tall.

Vernacular name. Akar engkaranda, Akar engkarandeh (Iban Lundu, Sarawak), Akar rosan (Iban, Sarawak)

Notes. In Sarawak, this species is found to be associated with *Artocarpus annulus* (Moraceae) and also *Elaeocarpus* tree. It is the host plant for *R. tuan-mudae* in Sarawak and *R. keithii* in Sabah. It has also been reported that the local fishes, known as *Sema* and Tengadak eat the berries when it fell into the river.

Selected specimens examined. BORNEO. Sarawak, Kapit, Pelagus resort, Secondary mixed dipterocarp forest, *WNF 19*, 80 m; *WNF 20*, 117 m, 10 April 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bau, Mt. Jambusan, Limestone forest, *WNF 205*, 12 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Bau, Wind cave, Limestone forest, *WNF 202*, 30 m, 12 July 2016, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Padawan, Tiang Bukap, Mt. Tiang Bukap, Limestone forest, *WNF 207*, 58 m, 13 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Semantan, Tg. Datu National Park, Secondary mixed dipterocarp forest, *WNF 47*, 11 April 2014, W. N. Fatiha et al. (UNIMAS Herb.); Miri, Mt. Mulu National Park, Secondary mixed dipterocarp forest, *WNF 48*, 12 May 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, Secondary mixed dipterocarp forest, *WNF 49*, 20 January 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Semantan, Tg. Datu National Park, Secondary mixed dipterocarp forest, *WNF 50*, 11 April 2014, W. N. Fatiha et al. (UNIMAS Herb.); Lundu, Mt. Gading National Park, Secondary mixed dipterocarp forest, *WNF 51, WNF 52, WNF 53*, 12 October 2014, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Bintulu, Wilmar Plantation, Secondary mixed dipterocarp forest, *WNF 54*, 23 September 2014, W. N. Fatiha et al. (UNIMAS Herb.); Kuching, Matang Wildlife Centre, Secondary mixed dipterocarp forest, *MBT 02*, 10 February 2015, Ibrahim Izzat et al. (UNIMAS Herb.); Kuching, Matang Wildlife Centre, Secondary mixed dipterocarp forest, *MW 13*, 17 February 2015, Ibrahim Izzat et al. (UNIMAS Herb.); Padawan, Borneo Highland Resort, Limestone forest, *WNF 62*, 29 November 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kuching, Kubah National Park, Secondary mixed dipterocarp forest, *WNF 63*, 733 m, 3 February 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kuching, Kubah National Park, Secondary mixed dipterocarp forest, *WNF 64*, 496 m; *WNF 67*, 419 m; *WNF 68*, 419 m; *WNF 69*, 329 m; *WNF 70*, 412 m; *WNF 71*, 226 m, 4 February 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Serian, Ranchan Pool, Secondary mixed dipterocarp forest, Near waterfall, *WNF73*, 14 April 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Semantan, Mt. Pueh, Secondary mixed dipterocarp forest, *WNF74,* 17 February 2014 (UNIMAS Herb.); Semantan, Mt. Pueh, Secondary mixed dipterocarp forest, *WNF 75*, 26 May 2014, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Semantan, Mt. Pueh, Secondary mixed dipterocarp forest, *WNF 76*, *WNF 77, WNF 79*, 24 October 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Lundu, Mt. Gading National Park, Secondary mixed dipterocarp forest, *WNF 82*, 31 December 2014, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Lundu, Mt. Gading National Park, Secondary mixed dipterocarp forest, *WNF 26*, 2 January 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Lundu, Mt. Gading National Park, Secondary mixed dipterocarp forest, *WNF 83*, 20 September 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Semantan, Tg. Datu National Park, Mt. Arol, Station 2 in active Rafflesia site, Secondary

mixed dipterocarp forest, *WNF 174*, 8 April 2014, W. N. Fatiha et al. (UNIMAS Herb.); Lundu, Mt. Gading National Park Host plant *R. tuan-mudae*, *GG19*, 5 Devember 2014, W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Mixed dipterocarp forest, Host plant *R. tuan-mudae*, *GG23*, 31 December 2014, W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Mixed dipterocarp forest, Host plant *R. tuan-mudae*, GG26, 30 April 2015, W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Mixed dipterocarp forest. Host plant *R. tuan-mudae*, *GG28*, 22 June 2015, W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Mixed dipterocarp forest, Host plant *R. tuan-mudae*, *GG32*, 9 July 2015 W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Mixed dipterocarp forest, Host plant *R. tuan-mudae*, *GG34*, 1 August 2015, W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Host plant *R. tuan-mudae*, *GG36*, 20 September 2015, W. N. Fatiha (UNIMAS Herb.); Lundu, Mt. Gading National Park, Mixed dipterocarp forest, Host plant *R. tuan-mudae, GG38*, 22 October 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Sri Aman, Batang Ai National Park, Host plant R. tuan-mudae, BASP3, 4 August 2015, Connie Geri (UNIMAS Herb.); Semantan, Mt. Pueh, Disturbed forest, Host plant *R. tuan-mudae*, *KP2*, 26 May 2014, W. N. Fatiha (UNIMAS Herb.); Semantan, Mt. Pueh, Disturbed forest, Host plant *R. tuan-mudae*, KP5, 12 February 2015, W. N. Fatiha (UNIMAS Herb.); Semantan, Mt. Pueh, Disturbed forest, Host plant *R. tuan-mudae*, *KP10*, 24 October 2015, W. N. Fatiha (UNIMAS Herb.); Semantan, Mt. Pueh, Disturbed forest, Host plant *R. tuan-mudae*, *KP 11*, 24 October 2015, W. N. Fatiha (UNIMAS Herb.); Padawan, Tapak Rafflesia Kampung Temurang, Host plant *R. tuan-mudae*, *KT1*, 10 November 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Bakelalan, Bario, W. Brooke 10043, 16 August 1955, W. Brooke (SAR); Meruli, 4th Division, Dapoi, Bukit Kelaoy, Hillside, *S. 22949*, 3 April 1965, Ilias Paie (SAR, SING, SAN); Kuching, Sebemban/Lundu, On lower ridges of disturb forest, *S. 63874*, 28 November 1991, Hj. Othman Ismawi et al. (SAR, SAN, KEP, K, L, MO); Sri Aman, 7th Division, Lanjak Entimau Wildlife Sanctuary, Alluvial forest, *S. 65078*, 110 m, 4 July 1993, Yii Puan Ching (SAR, KEP, SAN); Kuching, Penrissen road, 12th Mile, Riverside, *S. 29254*, 11 November 1966, Banyang ak Nudong & Sibat ak Luang (SAR, KEP, SAN, SING, K, L, A, BO); Banyeng Ak Nudong & Sibat Ak Luang (SAR, SING, SAN, KEP); Kapit, Bukit Kumbong, Batang Balui, Riverine forest, *S. 62044*, 700 m, 1 March 1992, Runi et al. (SAR, SAN, KEP); Tatau, Ulu Merirai, Gua Tiang, *S. 95528*, 8 July 2005, 250 m, Malcom et al. (SAR, KEP, SING, SAN); Kuching, Bau, Bukit Kit Lian San, S. 70093, 115 m, 19 December 1994, Rantai Jawa et al. (SAR, KEP); Lundu, Mt. Gading National Park, Entry from Kampung Sebemban, *S. 69343*, 12 November 1994, Awg Enjah et al. (KEP, SAN, SAR); Kapit, Hose Mt., Sungai Temiai, Mujong, *S. 64012*, 1200 m, 2 December 1991, Lai et al. (SAR, KEP, SAN); Kapit, Belaga, Batu laga Plateau, *S. 72289*, 1100 m, 26 June 1995, Yii et al. (SAR, KEP); Lawas, Path from Long Ugong to Long Semadoh, Near river, Secondary forest, 3000 ft, *S. 26566*, 18 October 1967, Ilias Paie (SAR); Kuching, Padawan, Tiang Bekap, Base of limestone hill, *S. 12539*, 200 ft, 5 June 1960, J. A. R. Anderson (SAR); Kapit, Rh. Unyat, Ng. Sebilat, Ulu Gaat, *S. 50129*, 26 March 1987, Dyg. Awa & Bernard Lee (SAR, KEP); Miri, 4th Division, Slopes of Mt. Api in Melinau George, Lower slopes of limestone mountain on litter overlying and between limestone rocks, *S. 24046*, 1000 ft, 17 February 1966, J. A. R. Anderson (SAR, SING, K, L); Kakus, Simpang Tiga, Ulu Mayeng, *S. 19228*, 200 m, 4 October 1963, Paul Chai (SAR, SING, SAN, KEP, BO); Semantan, Kg. Pueh, P. 4644, 100 ft., 21 September 1955, J. W. Purseglove & M. Shah (SAR); Miri, 4th Division, Ulu Sungei Sekaloh, Niah river, Primary lowland dipterocarp forest on clay loam soil, *S. 29139*, 7 December 1966, Erwin Wright (SAR, SING, KEP, BO, K, L, A); Bintulu, Tubau, Bukit Sekiwa, *S. 52799*, 200 m, 26 August 1986, Abg. Mohtar et al. (SAR, KEP, SAN); Kapit, Horse Mt., Above gorge of S. Simpunai, *B. 4928/A*, 15 September 1967, B. L. Burtt & A. M. Martin (SAR); Ulu Lawas, Kota Forest reserve, on riverbank of Sungai Kota in between sandstone boulders, *S. 31111*, 21 October 1971, Paul Chai & Ilias Paie (SAR, SING, SAN, BO, KEP); Belaga, 7th division, Batu Laga, Plateau, Batang Balui, Submontane mossy forest, *S. 56806*, 950 m, 14 March 1989, Yii Puan Ching (SAR, SAN, KEP, MO, K, L); Bario, Kelabit Highlands, Beyond airstrip, ALM 4300, 1020 m, 14 April 1995, A. Latiff (SAR).

4. *Tetrastigma dubium* (Laws.) Planch.
in DC. Monog. Phan. 5 (1887) 437; Suessenguth in Engler and Prantl., Nat. Pfl. Fam. 20d (1953) 324. Latiff in the Gard. Bull. Sing., 4 (36 (1983) 219; J. Bombay Nat. Hist. Soc. 81 (1984) 129; Not. Syst. 1-2 (1909-1911) 324. *Vitis dubia* Lawson in Hooker f. Fl. Brit. Ind. 1 (1875) 661. Type: India, Sikkim, Hooker f. s.n., (Isotype, K!). *Tetrastigma wrayi* (King) Craib, Fl. Siam. Enum. 1 (1926) 314; Suessenguth in Engler and Prantl, Nat. Pflanzenfam. 20d (1953) 323. nom. illeg. (including the type of *Cayratia wrayi*). *Vitis wrayi* King, J. As. Soc. Beng. 65, 2 (1896), in part; Ridley, Fl. Mal. Penin. 1 (1922) 475 in part – Type: Malay Peninsula, Perak, Scortechini 232 (K)

Stem hollow, glabrous, longitudinally striate, 0.2-0.3 cm across, lenticels few, not prominent on young. Tendrils simple, rarely furcate, some leaf opposed, 5.0-7.5 cm or longer, 0.3-1.0 mm across, glabrous. Leaves 3-foliate, rarely unifoliate- 6-foliate, chartaceous, glabrous when young, hairy on midrib when becoming mature, the petioles 1.5-10.5 cm long, 1.2-2.1 mm thick, few lenticels, not prominent, longitudinally striate, terminal leaflet elliptic, 10.5-14.0 cm long, 3.5-6.0 cm wide, the apex acuminate, the base attenuate, the margin serrate, veins 4-7 pairs, prominent above and below, midrib becoming flattened above and below, the petiolules 1.0-2.5 cm long, lateral leaflets asymmetric elliptic to obovate, 3.7-12.5 cm long, 1.5-5.0 cm wide, the apex, base, margin, primary and secondary venation as in terminal leaflets, the petiolules 0.5-1.0 cm long. Inflorescence axillary, peduncled, 2.5-6.0 cm long, pubescent, cyme dichotomus. Staminate flowers 0.3 cm long, pubescent. Pistillate flowers 0.3 cm long, pubescent, the staminode 0.1 cm, the stigma-lobe terete. Berries, purple when ripe, 0.4-0.7 cm diameter, globose, usually 2-seeded; seeds 0.6 x 0.4 cm, globose, the endosperm M-shaped in cross section.

Distribution. Borneo (Sarawak, Sabah), India, Myanmar, Thailand, Peninsular Malaysia

Habitat. On the margin of lowland dipterocarp-forest, submontane, and limestone forest. In Sarawak, this species grows on igneous derived brownish-yellow sandy soil.

Vernacular name. Akar enkerandah (Iban Kuching, Sarawak)

Notes. This species can climb up to 4-6 m high on Aglaia tree. Young fruits are pale green. The fruits are used as baits for fishing.

Selected specimens examined. BORNEO. Sarawak, Padawan, Mt. Bengoh, WNF212, 15 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Mt. Tiang Bukap, Padawan, WNF210, 28 m, 13 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Borneo Highlands, WNF55, 848 m, 10 October 2014, W. N. Fatiha et al. (UNIMAS Herb.); Serian, Bukit Rembun, Jalan Gedong, S.61619, 14 March 1988, Hj. Othman Ismawi (SAR); Bau, Bukit Jebong, 1st Division, S.25637, 300 ft, 29 April 1967, Paul & Ilias (SAR); Simunjam, Gunung Buri, 1st/2nd Division boundary, S.36756, 530 m, 16 September 1975, Paul Chai (SAR, KEP, L, K); Kuching, Matang, Haw. 594, 400 ft., - (SAR); Kuching, Tiang Bekap, Padawan Rd., S.12536, 200 m, 5 Jun 1960, J.A.R. Anderson (SAR, K); Bukit Mentawa, Mile 34, Padawan Road, Kuching, 1st Division, S.41060, 2 September 1979, James D. Mamit (SAR, L, K).

5. *Tetrastigma glabratum* (Blume) Planch.

DC., Monog. Phan. 5, 2 (1887) 430; Robinson, Philip. J. Sci. Bot. 6 (1911) 260; Gagnep., Not. Syst. 1 (1910) 318 et (1911) 379; Robinson, Philip. J. Sci. (Bot.) 6 (1911) 260; Craib in Contributions to the Flora of Siam, 1 (1912) 41; Merrill, Enum. Philip. Fl. Plt. 3 (1923) 3; Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 322; Backer and Bakhuizen van den Brink, Fl. Java 2 (1965) 90. *Cissus glabrata* Blume, Bijdr. 1 (1825) 189 – Type: Java, s.l., Blume s.n. (L). *Vitis glabrata* (Blume) Backer, Schoolfl. Java (1911) 253; in Spach, Hist. Nat. Veg. (Phan), 23, t3 (1848) 227 – Type: Indonesia, Java, s. l., Blume s. n. (Lecto. L).

Large liana, glabrous. Stem terete, hollow, longitudinally striate, 0.3-0.5 cm across, lenticels prominent, ocellate, some coalesced. Tendrils simple, ca. 8 cm long or longer, 0.1 cm across. Leaves 3-foliate, rarely 2-foliate, coriaceous, glabrous, glossy, the petioles 5.5-7.0 cm long, 0.1-0.2 cm across, striate, the stipule triangular, 0.1-0.3 cm long, 0.2-0.3 cm wide at base; terminal leaflets lanceolate to elliptic, 8.0-10.0 cm long, 3.0-5.0 cm wide, the apex mucronulate to caudate, the base acute to rounded, the margin serrate, primary venation 4-6 pairs, less conspicuous above and prominent and raised below, midrib becoming flatten above and below, secondary venation less prominent, almost obsolete, the petiolules 1.5-3.5 cm long, lateral leaflets 5.2-8.0 cm long, 3.0-4.0 cm wide, the apex, base, margin, primary and secondary venation as in terminal leaflets, the petiolules 0.5-1.0 cm long. Inflorescence peduncle, 1-1.3 cm long, transluscent-green, dichotomous cyme. Berries globous, 1.5 x 1.3 cm, 1-3-seeded, 0.7 x 1.3 cm, plano-convex, chalazal groove prominent, chalazal knot extending ¾ of the seed length.

Distribution. Borneo (Sarawak, Sabah, Kalimantan)

Habitat. This species mostly grow on the margin of mixed dipterocarp to submontane forest at elevation from 80 to 1300 m above sea level. This species was also recorded to grow nearby small stream.

Vernacular name. Akar Engkarandah Buah Besar (Iban Kapit, Sarawak)

Notes. This species can climb up to 30 m tall. The stem is in greenish brown. The fruit is in dark green and turn to yellow when ripe. In Kalimantan, the species is associated with plant from family of Myrtaceae, and Meliaceae.

Selected specimens examined. BORNEO. Sarawak. Kapit, Pelagus resort, *WNF 215*, 80 m, 11 April 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bintulu, Wilmar Plantation, HCV4, *WNF 87, WNF 88, WNF 89*, 23 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Lingga, 2nd Division, Gunong Lesung, Hansen 1116, 400 m, 1981, 2 December 1981, Carlo Hansen (SAR); Kuching, Stampin, 5 Miles, South of Kuching, *S. 22771*, 6 January 1966, J. A. R. Anderson (SAR, K, L, A, SING); Kuching, Setapok Forest Reserve, 4th miles South of Kuching, Disturbed peat swamp forest, *S. 19698*, 16 May 1966, J. A. R. Anderson (SAR, K, L); Kapit, 7th Division, Nanga Sebatu, Sungai Mengiong, Balleh, *S. 62120*, 5 November 1988 (SAR).

6. *Tetrastigma hookeri* (Lawson) Planch.

in DC., Monog. Phan. 5, 2 (1887) 428; Suessenguth in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 325; Backer and Bakhuizen v.d. Brink, Fl. Java 2 (1965) 89; Latiff, Gard. Bull. Sing. 36, 2 (1983) 223. Vitis hookeri Laws. in Hooker f., Fl. Brit. Ind. 1 (1875) 661; Backer, Schoolfl. Java (1911) 253; J. Linn. Soc. Bot. 43 (1915-1917) 465 – Type: India, Sikkim, Hooker f. 162 (K!)

Large liana, glabrous. Stem terete, hollow, longitudinally striate, 0.2-0.3 cm across, lenticels few, not prominent. Tendrils simple, striate, 6 cm or longer, 0.2 cm across. Leaves pedately 5- to 7-foliolate, rarely unifoliate, rarely 3-foliate, coriaceous, glabrous, the petioles 10.7-16.2 cm, swoolen at base with growth rings in light brown, the stipules absent; terminal leaflets 15.1-25.6 long, 7.0-13.4 cm wide, broadly elliptical to obovate, apex acuminate to caudate, base acute to rounded, margin coarsely dentate, primary venation 6-10 pairs, less prominent above, very prominent below, raised, secondary venation prominent above and below, not raised; the petiolules 2.6-3.7 cm long, 0.2 cm across, striate, present growth rings; lateral leaflets 12.4-22.8 long, 5.1-9.4 cm wide, elliptical, base acute to rounded, the apex, margin, and veins as in terminal leaflets, the petiolules 2.2-3.1 cm, striate, present growth rings. Inflorescence a dichotomous cyme, the peduncles 2.3-2.5 cm. Berries 3.2-4.5 cm in diameter, globose, usually 1-seeded; seeds ca.1.8 x 0.8 cm wide, ellipsoid, the testa rugulose

Distribution. Borneo (Sarawak, Kalimantan), India, Java, Myanmar, Peninsular Malaysia, Sumatra and Thailand

Habitat. This species is mostly found in Limestone forest in Sarawak.

Notes. This species climb up to 5 m high and is associated with other plant climber.

Vernacular name. Not known

Specimen examined. BORNEO. Sarawak. Bau, Tasik biru, *WNF34*, 23 April 2015, W. N. Fatiha (UNIMAS Herb.); Bau, Wind cave, *WNF35*, 26 April 2015, W. N. Fatiha (UNIMAS Herb.); Padawan, Mt. Tiang Bukap, *WNF210*, 28 m, 13 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Padawan, Mt. Jambusan, Bau, *WNF203, WNF204*, 12 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.). Kalimantan. West Kalimantan, Mt. Bentuang area, Masa village, 150 km NE of Pontianak, 3130, 28 June-6 July 1989, J. S. Burley et al. (KEP).

7. *Tetrastigma megacarpum* Latiff
Blumea 35 (2): 561 – Type: Borneo, Central East Kalimantan, West Kutai, Endert 4942 (L).

Large liana, glabrous. Stem rounded to terete, winged, hollow, longitudinally striate, 0.7-1.4 cm across, corky part become winged, lenticels prominent, ocellate, some coalesced. Tendrils simple, 0.2-0.3 cm across, ca. 10 cm long or longer. Leaves 5-foliate, digitate, rarely 3-4-foliate, chartaceous to coriaceous, glabrous, glossy on both forward and reverse; the petioles 12-22.5 cm long, 0.3-0.4 cm across, longitudinally striate, the stipules 0.6-0.8 cm long, 0.3-0.4 cm wide, not persistent; terminal leaflets elliptic to obovate, 17.5-18.0 cm long, 6.5-9.5 cm wide, glabrous on both sides, the apex caudate, the base acute, the margin grossly serrate, primary venation 6-8 pairs, less conspicuous above and prominent below, midrib becoming flatten above and below, secondary venation less prominent to obsolete, the petiolules 4.0-7.5 cm long, lateral leaflets 14.5-19.0 cm long, 6.8-8.0 cm wide, the apex, base, margin, and primary and secondary venation as in terminal leaflets, the petiolules 2.5-6.0 cm long. Inflorescence axillary, umbellate cymes, peduncled, 2.5-5.0 cm long. Staminate flower not observe. Pistillate flowers oblong, pubescent, calyx cupuliform, lobed, petals oblong, corniculate, 0.3-0.5 cm wide, style 0.5 cm long. Berries green, rounded when fresh, turn to oblong when dry, 0.5-1.4 cm long, 0.3-1.1 cm wide, 4-seeded, seed oblong, 1.4 x 0.8 cm, chalazal groove prominent.

Distribution. Sarawak, Sabah, Kalimantan

Habitat. In Sarawak, this species is found in various type of forests such as mixed dipterocarp, riverine, and limestone forest. It is commonly found in waterfall area or near riverbank.

Vernacular name. Akar emperkak, Akar anggur, Akar ruran (Iban, Sarawak), Kah kudip (Land Dayak, Sarawak)

Notes. This species is endemic to Borneo. It has winged stem that is a characteristic to this species. The root morphology of this species is homorhizic root system.

Selected specimens examined. BORNEO. Sarawak. Padawan, Mt. Bungoh, Kampung Bungoh, Secondary mixed dipterocarp forest, *WNF213*, 70 m, 15 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Padawan, Mt. Tiang Bukap, WNF210, 28 m, 13 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Serian, Ranchan Pool, Secondary mixed dipterocarp forest, *WNF129,* 14 April 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Serian, Ranchan Pool, Secondary mixed dipterocarp forest, *WNF201*, 26 October 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu, camp 3, *WNF38, WNF122*, 30 August 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu, *WNF37, WNF124, WNF125,* 20 January 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu, *WNF41*, 1 September 2014 (UNIMAS Herb.); Miri, Mt. Mulu, *WNF39, WNF43, WNF135, WNF136, WNF143, WNF144, WNF145, WNF146, WNF148, WNF149,* 3 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF42,* 4 September 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Batang Ai National Park, Bebiyong Mit trail, *WNF126,* 22 October 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Serian, Ranchan Pool, Secondary mixed dipterocarp forest, *WNF123, WNF127, WNF128, WNF130*, 14 April 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bau, Wind cave, *WNF131, WNF132,* 26 April 2015 (UNIMAS Herb.); Miri, Mt. Mulu National Park, Secondary mixed dipterocarp forest, WNF133, 12 May 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, WNF134, 26 August 2014 (UNIMAS Herb.); Miri, Mt. Mulu National Park, Secondary mixed dipterocarp forest, *WNF138, WNF139, WNF140, WNF142,* 25 August 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herbarium); Miri, Mt. Mulu National Park, WNF137, *WNF147, WNF150*, 5 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Batang Ai National Park, Secondary mixed dipterocarp forest, *WNF 168*, 23 October 2014, Connie Geri (UNIMAS Herb.); Sri Aman, Engkilili, Kumpang Linggir, *WNF 9*, 30 January 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bau, Bukit Tabai, Tai Ton, *S. 22864*, 100 ft., 16 December 1965 P. Chai & L. H. Seng (SAR, K, L); Kuching, Padawan, 1st division. Teng Bukap, 32nd Padawan road, S. 32623, 12 January 1973, James Mamit & S. Tong Jugah (SAR, SING, SAN, L, K); Kuching, Padawan, 1 st division, Mt. Braang, Padawan, *S. 41092*, 2 September 1979, James D. Mamit (SAR; , KEP, SAN, L, K); Marudi, 4th Division, Long Dam, Ulu Dapoi, Tinjar, *S. 23443*, 10 April 1965, Haji Suib (SAR, K); Belaga, 7th Division, Punan Busay, GSY 601, 17 June 1971, Geh & Samsuri (SAR); Bau, 1st division, Lobang Angin, Bau Limestone Hills, *S. 51274*, 50 m, 18 November 1985, Yii et al. (SAR, SAN, KEP); Lawas, 5th division, Yong Khaw area, Bangkor, Mixed dipterocarp forest in recently exploited area *S. 31583*, 3 November 1971, Paul Chai & Ilias Paie (SAR, SING, SAN, K, L); Song, Lanjak Entimau Wildlife Sanctuary, *S. 78093*, 370 m, 31 March 1998, Patsipun et al. (SAR); Penrissen, Mt. Braang, *S. 84074*, 8 December 2000 (SAR); Serian, Gunung Niyat, Ulu Sg. Majat, MDF, *S. 85509*, 27 February 2002, Jamree, S. & Enjah, A. (SAR, K, L); Kuching, Bau, Fairy cave Limestone forest, *S. 70058*, 75 m, 16 December 1994, Rantai Jawa et al. (SAR, KEP, SAN).

8. *Tetrastigma papillosum* (Blume) Planch.

in DC., Monog. Phan. 5 (1887) 429; Gagnep., Not. Syst. 1 (1910) 317; Merrill, Philip. J. Sci. 11, 3 (1916) 137 et Enum. Philip. Fl. Plt. 3 (1923) 4; Lau¬terbach, Bot. Jahrb. 59 (1925) 512Suessenguth in Engler and Prantl, Nat. Pfl. Fam. 20d (1953) 320; Backer and Bakhuizen v.d. Brink, Fl. Java 2 (1965) 88; Latiff, Gard. Bull. Sing 36(2) (1983) 226. Cissus papillosa Blume, Bijdr. 1 (1825) 183. Vitis papillo¬sa (Blume) Backer, Schoolfl. Java (19110 252 – Lectotype: Indonesia, java, Blume s.n., Java (L! isolectotypes K! BM!) *Cissus suberosa* Elm., Leafl. Philip. Bot. 2 (1908) 493. Vitis pubiflora var. papillosa Miq., Ann. 1 75.

Older stems with spine-like corky excrescences. Young stems hollow, 1.4-1.8 cm in diameter, longitudinally striate, lenticels not prominent. Tendrils furcate, some leaf opposed, 8.8 cm long or longer, 0.2 cm across. Leaves digitately 3-foliolate, rarely 2-foliate or unifoliate, coriaceous, glabrous on above and below surfaces, the midrib raised, the margin coarsely crenate, primary venation 6-8 pairs, not prominent above, very prominent below, secondary venation not prominent above, very prominent below, raised, the petiole 3.3-7.5 cm long, 0.2-0.3 cm across, longitudinally striate, swollen petiole, glabrous, lenticels not prominent; the stipules triangular, 0.2-0.5 cm long, 0.4-0.5 cm wide at base, glabrous; terminal leaflets 8.2-9.7 x 3.6-4.8 cm, elliptical to obovate, acuminate apex, obtuse at base, coarsely crenate, the petiolule 2.7-3.3 cm; lateral leaflets 7.6-8.9 x 3.1-3.6 cm, elliptic, the apex, base and the margin as in terminal leaflets, the petiolule 1.0-1.4 cm. Inflorescence axillary, peduncled, 1-2 cm long, corymbose cyme. Staminate flowers pubescent; pistillate flower 0.2 cm long, pubescent, the staminode c. 0.5 mm, the stigma-lobe terete. Berries red, 0.6 x 0.7 cm. Seed 0.5 x 4.0 cm, 3-seeded convex-carinate, testa ridged.

Distribution. Borneo (Sarawak, Sabah, Kalimantan), Papua New Guinea, Peninsular Malaysia and Sumatra

Habitat. This species inhabits mixed dipterocarp forest and mostly on high elevation, up to 1550 m.

Vernacular name. Wur Siri (Kelabit, Sarawak), Akar Engkarandah (Iban, Sarawak).

Notes. The prominent corky excrescences (modified lenticels) is unique to this species.

Selected specimens examined. BORNEO. Sarawak. Padawan, Mt. Bungoh, Kampung Bungoh, *WNF 213*, 70 m, 15 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Mt. Tiang Bukap, Padawan, *WNF 210*, 28 m, 13 July 2016, W. N. Fatiha & Jegong (UNIMAS Herb.); Serian, Ranchan Pool, *WNF 129*, 14 April 2015, W. N. Fatiha et al. (UNIMAS Herb.); Serian, Ranchan Pool, *WNF 201*, 26 October 2014, W. N. Fatiha et al. (UNIMAS Herb.); Miri, Mt. Mulu, camp 3, *WNF 38, WNF 122,* 30 August 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu, Along trail to summit, *WNF 37, WNF 124, WNF 125*, 20 January 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu, camp 1, *WNF 41*, 1 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu, *WNF 39, WNF 43, WNF 135, WNF 136, WNF 143, WNF 144, WNF 145, WNF 146, WNF 148, WNF 149*, 3 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 42*, 4 September 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Batang Ai National Park, Bebiyong Mit trail, WNF 126, 22 October 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Serian, Ranchan Pool, *WNF 123, WNF 127, WNF 128, WNF 130,* 14 April 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bau, Wind cave, WNF 131, WNF 132, 26 April 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 133,* 12 May 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, WNF 134, 26 August 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 138, WNF 139, WNF 140, WNF 142,* 25 August 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 137, WNF 147, WNF 150,* 5 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Batang Ai National Park, *WNF 168*, 23 October 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Engkilili, Kumpang Linggir, *WNF 9*, 30 January 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Limbang, Lawas, Bukit Bimuda, Montane forest, *S. 60750*, 1200=m, 19 March 1991, Runi et al. (SAR, SAN, KEP, K, L, MO); Baram district, Perupayang, Kelabit Highland, About 60 years old secondary forest, S. 35509, 1180 m, 14 November 1974, Paul Chai (SAR, SAN).

9. *Tetrastigma pedunculare* (Wall. ex Lawson) Planch.

In DC., Monog. Phan. 5, 2 (1887) 438; Gagnep., Not. Syst. 1 (1911) 317; Suessenguth in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 319; Latiff, Gard. Bull. Sing. 36(2) (1983) 225. *Vitis peduncularis* Wall. in Laws. in Hooker f., Fl. Brit. Ind. 1 (1875) 655; King, J. As. Soc. Beng. 65, 2 (1896) 393; Ridley, Fl. Mal. Penin. 1 (1922) 474.
Type: Peninsular Malaysia, Penang, Wallich Cat. 6024 (K!, Iso. SING). *Tetrastigma papillosum* K. Schum. non Planch., Fl. Kais. Wil¬helmsl. (1889) 72. *Tetrastigma pubiflorum* (Miq.) Suesseng. *Vitis pubiflora* Miq., Ann. Mus. Bot. Lugd. Bat. 1 (1863-64) 74. *Vitis pubiflora* K. Schum., Fl. Deutsch. Schtzgeb. (1900) 208, non Miq.

Large liana, hairy. Stem rounded, hollow, longitudinally striate, 0.2-0.4 cm in diameter, lenticels conspicuous, some ocellate, flatten. Tendrils furcate, 0.1-0.3 cm across, 16 cm or longer. Leaves digitately 3-foliolate, rarely 2-4-foliate, coriaceous, glabrous on leaflets, slightly with hairs on midrib, densely covered with glaucous fine indumentums beneath, the petiole 5.5-13.3 cm long, 0.1-0.2 cm across, hairy, swollen at base, lenticels not prominent, longitudinally striate, the stipules triangular, 0.2-0.3 cm long, 0.2-0.4 cm wide at base, hairy; terminal leaflets 9.5-22.2 cm long, 5.0-11.4 cm wide, broadly elliptical to obovate, acuminate, acute at base, the margin serrate, primary venation 6-8 pairs, less conspicuous above, very prominent below, midrib hairy, becoming flatten above and below, secondary venation becoming very prominent on matured leaflets, the petiolules 1.5-3.0 cm long, 0.1-0.2 cm across, hairy; lateral leaflets 8.0-16.8 cm long, 4.5-11.8 cm wide, the leaf shape, apex, base, margin, primary and secondary venation as in terminal leaflets, the petiolules 0.5-2.0 cm long, 0.1-0.2 cm across, hairy. Inflorescence axillary, peducled hairy, 1.2-2.4 cm long, cyme dichotomus, often borne on older branches or stem. Pistillate flower oblong, pubescent, calyx cupuliform, lobed, petals oblong. Staminate flowers oblong, pubescent, the staminoides about 0.1 cm long, the stigma-lobe terete. Berries rounded, red purple in fresh state, 0.3 x 0.7cm long, 0.4-0.5 cm wide when ripe; seeds 0.2-0.5 cm long, 0.3-0.4 cm wide, convex carinate, the testa ridge.

Distribution. Borneo (Sarawak, Sabah, Kalimantan), Peninsular Malaysia, Sumatra, Papua New Guinea

Habitat. In Sarawak, the species can be found mostly in mixed dipterocarp forest, especially at logged-over area and forest ridge.

Vernacular name. Ngihris (Bidayuh), Akar loran (Iban), Akar ruran (Iban Lubuk Antu), Akar ingkarandah (Iban Kapit), Wal Po (Saban)

Notes. The young stems, petioles, hairs on the midrib of this species are red in colour. This species is the host for *Rhizanthes lowii* and *R. zippelli* which was discovered in Long Banga, Ulu Baram, Sarawak.

Selected specimens examined. BORNEO. Sarawak. Baram, Long Banga, Scientific expedition Heart of Borneo, along trail 6, mixed dipterocarp forest, *WNF 216, WNF 217, WNF 218, WNF 220, WNF 223, WNF 224, 662 m, WNF 225, WNF 226*, 684 m, 22 August 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Long Banga, Scientific expedition Heart of Borneo, along trail 12, mixed dipterocarp forest, *WNF 234*, 638 m, 23 August 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Long Banga, Scientific expedition Heart of Borneo, along trail 16, mixed dipterocarp forest, *WNF 257*, 597 m, *WNF 258*, 611 m, *WNF 259*, 625 m, *WNF 264,* 637 m, 25 August 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Long Banga, Scientific expedition Heart of Borneo, along trail 17, Mixed dipterocarp forest, *WNF 277,* 610 m, 27 August 2016, W. N. Fatiha & S. N. Aishah(UNIMAS Herb.); Long Banga, Scientific expedition Heart of Borneo, along trail from base camp, mixed dipterocarp forest, *WNF 282,* 589 m, *WNF 283,* 594 m, *WNF* 285,

596 m, 28 August 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Long Banga, Scientific expedition Heart of Borneo, logged over area to trail 15, mixed dipterocarp forest, *WNF 288*, 704 m, 28 August 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kapit, Pelagus resort, Mixed dipterocarp forest, *WNF 21,* 133 m, 10 April 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kuching, Kubah National Park, WNF 36, WNF 108, *WNF 84, WNF 85, WNF 86,* 3 February 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Batang Ai National Park, Sekuyong river, *WNF 171*, 23 October 2014, W. N. Fatiha et al. (UNIMAS Herb.); Sri Aman, Batang Ai National Park, *WNF 200*, 2 August 2015, W. N. Fatiha et al. (UNIMAS Herb.); Kubah National Park, *WNF 106, WNF 107, WNF 109*, *WNF 110, WNF 154*, 4 February 2015, W. N. Fatiha et al. (UNIMAS Herb.); Semantan, Mt. Pueh, WNF 78, 24 October 2015, W. N. Fatiha et al. (UNIMAS Herb.); Bau,Tasik Biru, *WNF 153, WNF 152,* 23 April 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Miri, Mt. Mulu National Park, HQ, *WNF 121,* 10 May 2015, W. N. Fatiha et al. (UNIMAS Herb.); Miri, Mt. Mulu National Park, Camp 1, WNF 120, 1 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bintulu, Wilmar Plantation, Bukit Dungan, Education trail, *WNF 156, WNF 151, WNF 169,* 23 October 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bau,Wind Cave, *WNF 157,* 26 April 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Miri, Mt. Mulu National Park, Botani loop, *WNF 119, WNF 158, WNF 159, WNF 160,* WNF 161, 5 September 2014 (UNIMAS Herb.); Miri, Mt. Mulu National Park, WNF 162, 4 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, WNF 163, WNF 164, 12 May 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 165*, 3 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 166,* 20 January 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, *WNF 167,* 26 August 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Padawan, Borneo Highland National Park, *WNF 170,* 29 November 2014, W. N. Fatiha et al. (UNIMAS Herb.); Lubuk Antu, From Ng, Talangon to upper of Sg. Lubong Baya, Batang Ai NP, Lews Lubok Antu, *S. 84214,* 225 m, 18 March 2000, Rantai Jawa et al. (SAR); Sri Aman, Lubok Antu, Batang Ai National Park, Sg. Talangan, Ulu Sg., Lubang Baya, Along river, *S. 84181,* 200 m, 16 March 2000, Rantai Jawa et al. (SAR, KEP); Penrissen, Mt. Braang, Limestone forest, *S. 84076,* 8 December 2000, Jemree (SAR); Miri, Ulu Baram, Foot of Mt. Pelamau, Sg. Tutoh, Logged over forest, *S. 76999,* 19 April 1997, Julaihi et al. (SAR); Miri, Subis, Tanjung Belipat, along boundary from Sg. Niah, Niah National Park, Disturbed forest, by path, moderate shade, *S. 89202*, 14 August 2002, Kit Pearce et al. (SAR, K); Batang Balleh, 7th division, Waterfall, Hose mountain, Ulu Sg. Merarai, Sandstone boulders at the base of waterfall, *S. 53773,* 550 m, 29 March 1987, Yii Puan Ching et al. (SAR, KEP, K, L); Miri, Mt. Mulu National Park, Camp 5, Helipad, Carlo Hansen No.137, 1977-1978, Carlo Hansen (SAR); Mukah, Ulu Balingian, Mukah hills, Mile 62 junction from Sibu, Shifring inltirasion site immediately after harvesting, *S. 71906,* 10 May 1995, P. Chai et al. (SAR, SAN, KEP); Bario, Baram, Sungai Kelapang, Ramudu, Near the river, *S. 75100,* 24 March 1997, Yahud et al. (SAR, SAN, KEP, K, L, MO); Marudi, Sungai Silat Basin, Sungai Palutan, *S. 91772*, 410 m, 25 March 2003, Jong, L. K. & Sam, Y. Y. (SAR, SAN, KEP); Miri, 7th division, S. Hose mountains, Sg. Melinau, Camp. 1, B. 122915, 19 July 1980, G. Butt (SAR); Kuching, Tiang Bekap, Mt. Maja, *CWL.1322*, 300 m, 13 March 1967, Chew Wee-lek (SAR); Kuching, Semantan, Mt. Pueh, Mixed dipterocarp forest, *S. 64316*, 200 m, 5 March 1992, Yii Puan Ching et al. (SAR, SAN, KEP, K, L); Belaga, Batu Laga, North-East of Dataran, Mossy forest, *S. 71339*, 840 m, 15 June 1995, Runi et al. (SAR); Serian, Tebedu, Bukit Payang near DID, *S. 82167*, 26 April 1999, Patsipun et al. (SAR); Kuching, Mt. Serapi, Kubah National Park, Mixed dipterocarp forest on mountain forest, rocky area, *S. 80532*, 700 m, 26 March 1999, Awg Enjah et al. (SAR, SAN, KEP, K, L, MO); Sri Aman, Mt. Mulu National Park, Alluvial forest N. W. of Melinau Gorge, 348, 90 m, 18 February 1978, I. Nielsen (SAR); Bintulu, 4th Division, Nanga Sapulow, Segan Forest Reserve, in mixed forest, Ding Hou No. 466, 30-50 m, 5 July 1966 (SAR); Kuching, Padawan, Stabut, 1st Division, *S. 29952*, 16 January 1970, James Dawos Mamit (SAR, K, L, BO, A, E, NEL); Bau, Behind Bukit Krian, *S. 22096*, 50 m, May 1964, Anderson et al.

(SAR, SAN, SING); Lubok Antu, Near Sg. Kaup, Ulu Sungai Engkari, on yellow sandy soil in secondary forest along river bank, *S. 34067*, 21 Mac 1974, Paul Chai (SAR, KEP, SAN, MO, L, K); Kuching, Semenggoh arboretum forest reserve, *11750*, 300 ft, March 1960, Asah (SAR, K, L, A); Kuching, Semantan, Mt. Pueh, Mixed dipterocarp forest, *S. 64309*, 200 m, 5 March 1992, Yii Puan Ching et al. (SAR, KEP, SAN, MO, K, L); Betong, Base camp to Bukit Sadok, on ridge, mossy forest, *S. 45015*, 14 October 1982, Ilias Paie & Manggi (SAR, KEP, SAN, K, L, MO); Balingian, Sungai Tau, P. 5162, 91 m, 29 May 1956, J. W. Puraoglove (SAR); Kapit, Hose Mountain, Sg. Temiaia, Mujong, *S. 64020*, 1200 m, 2 December 1991, Lai et al. (SAR, KEP, SAN); Tebedu, Bukit Merubang, Logged-over MDF, Bkt. Merubang, *S. 49260*, 9 February 1985, Abg. Mohtar et al. (SAN, KEP, K, L, MO); Sri Aman, Bukit Rawan, Tebekang area, 1st Division, *S. 45255*, 270 m, 2 April 1983, D. Awa & I. Paie (SAN, SAR, KEP); Bintulu, Bukit Nyegoh, *S. 97455*, 7 March 2007, Malcom et al. (SAR); Tebakang area, 1st Division, Bukit Alak, Lower slope of Bukit Alak, Secondary forest near to Sg. Tambing, *S. 45614*, 15 April 1983, Dyg. Awa & I. Paie (SAR, SAN, KEP, K, L); Kuching, Serian, Sabal Sawmill Sdn. Bhd., Sabal F.R., 70th Mile, On hillslope near boundary line, *S. 34332*, 183 m, 15 May 1974, Sylvester Tong (SAR, KEP, L, K); Kapit, Sg. Bena, Sut, 7th Division, on river bank *S. 41715*, 26 April 1980, Ilias Paie (SAR, KEP, SAN, L, K, MO); Lundu, Sungai batu, Mt. Pueh, Along the stream of Sg. Batu, Mixed dipoterocarp forest, *S. 56647*, 24 Mac 1989, Hj. Othman Ismawi et al. (SAR, SAN, KEP, MO, K, L); Seropak, Mt. Bungo range, 1st division, above Seropak, Valley forest with tall dipterocarp, *S. 43901*, 250 m, 9 March 1982, Banyeng & Dami (SAR, KEP, SAN, K, L); Sibu, Sungai Selintik, Jalan St. Leong, Oya Road, 24th Mile, Secondary forest of lowland dipterocarp forest, *S. 63383*, 14 February 1992, Hj. Othman et al. (SAR, KEP); Tebedu, Bukit Merubang, Logged over mixed dipterocarp forest, *S. 49260*, 15 July 1987, Abg. Mohtar et al. (KEP, SAR, SAN, K, L); Tatau, 4th Division, Ulu Asap, Secondary forest S. Kana, *S. 44843,* 170 m, 19 June 1982, Abg. Mohtar (SAR, KEP, SAN, L, K, MO); Kapit, Upper Rejang River, Clemens 21284, 1929, J. & M. S. Clemens (SAR); Belaga, Up River ex Punan Busang, 7th Division, *GSY 131*, 12 June 1971, Geh & Samsuri (SAR); Belaga, 7th Division, Punan Busang, *GSY 208*, 13 June 1971, Geh & Samsuri (SAR); Tebedu, Bukit Simurun, Logged-over forest, *S. 49288*, 12 February 1985, Abg. Mohtar et al. (SAR, SAN, KEP, K, L); Lubok Antu, Bukit Ubah Ribu, Ulu Sungai Kaup, 2nd division, on steep slope, *S. 33767,* 2200 ft, 11 March 1974, Paul Chai (SAR, KEP, SAN); Marudi, Sungai Silat Basin, Sungai Palutan, Mixed dipterocarp forest, *S. 91772*, 410 m, 25 March 2003 (SAR, KEP, SAN); Baram, Along main Baram river from upriver Liok Liseh to Long Selatong, Chin See Chung 2637, 24 March 1977, Chin See Chung (SAR).

10. *Tetrastigma rafflesiae* (Miq.) Planch.

in DC., Monog. Phan. 5, 2 (1887) 443; Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 325. *Vitis rafflesiae* Miq., Ann. Mus. Bot. Lugd. Bat. 1 (1863-64) 76. *Tetrastigma tuberculatum* (Blume) Latiff, Blumea. *Cissus tuberculata* Blume, Bijdr. 1 (1825) 189 – Type: Indonesia, Java, Blume s.n. (L). *Tetrastigma lanceolarium* (Roxb.) Planch. in DC. Monog. Phan. 5, 2 (1887) 423; Suessenguth in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 322; Backer and Bakhuizen v.d. Brink, Fl. Java 2 (1965) 89; Latiff, Gard. Bull. Sing. 36, 2 (1983) 222; Keng, Conc. Fl. Sing. (1990) 119. *Cissus lanceolaria* Roxb., Fl. Ind. 1 (1820) 430. *Vitis lanceolarium* (Roxb.) Wall. in Wight and Arn., Prod. Fl. Ind. Orient. 1 (1834) 128; Miq., Fl. Ind. Bat. Suppl. 1 (1860-61) 603 et Ann. Mus. Bot. Lugd. Bat. 1 (1863-64) 75; King, J. As. Soc. Beng. 65, 2 (1896) 395; Backer, Schoolfl. Java (1911) 254; Ridley, Fl. Mal. Penin. 1 (1922) 475, nom. illeg. (include type of *Cissus leucostaphylla*). *Tetrastigma mutabile* (Blume) Planch. in DC., Monog. Phan. 5, 2 (1887) 440; Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 323; Backer and Bakhuizen van den Brink, Fl. Java 2 (1967). *Cissus mutabilis* Blume, Bijdr. 1 (1825) 190. *Tetrastigma encephalospermum* Ridl., Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 322. *Tetrastigma kunstleri* (King) Craib, Fl. Siam Enum. 1 (1926) 313; Suessenguth in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 325. *Vitis kunstleri* King, J. As. Soc. Beng. 65, 2 (1896) 396; Ridley, Fl. Mal. Penin. 1 (1922) 475

Young stem black, terete, 2.6-4.1 cm in diameter, old stem flattened, 6.0-11 cm across, tuberculate. Tendrils simple, 11 cm long or longer, 0.2-0.3 cm across, longitudinally striate. Leaves 3-foliate to pedately 5- to 7-foliate, coriaceous, glabrous, the petiole 6.7-11.6 cm long, 0.2-0.3 cm long, longitudinally striate, few lenticels, the stipules triangular, 0.3-0.5 cm long, 0.3-0.4 cm wide at base, glabrous, not persistent; terminal leaflets 13.6-20.5 x 4.2-9.4 cm, lanceolate to elliptic, acuminate, acute at base, margin obscurely dentate, the midrib raised above and becoming flatten below, glabrous, primary venations 6-9 pairs, secondary venations not prominent above, prominent below, the petiolule 0.6-3.3 cm long, 0.2 cm wide, longitudinally striate, few lenticels; lateral leaflets 5.8-13.4 x 2.6-6.7 cm, lanceolate to elliptic, rounded to acute at base, the apex, margin, midrib, primary and secondary venations as in terminal leaflets, the petiolule 0.4-2.5 cm long, 0.2-0.3 cm across, longitudinally striate. Inflorescence axillary, peducled green, 0.5-2.0 cm long, cyme dichotomus. Staminate flowers ca. 0.2 cm long, ovoid. Pistillate flowers ca. 0.5 cm long, oblong, the staminoide ca. 0.5 cm long, the stigma-lobe rounded, ciliolate. Berries light green, 1.5-2.2 cm in diameter, globose when fresh, oblong when dried, 1-2-seeded; seed 1.2 x 0.6 cm, oblong, plano-convex, the testa rugulose, the endosperm M-shaped in cross-section.

Distribution. Borneo (Sarawak, Sabah, Kalimantan), India, Myanmar, Indochina, Thailand, Peninsular Malaysia

Habitat. In Peninsular Malaysia, this species is most widely distributed, being recorded from various habitats. In Sarawak, the species is mostly found on lower elevations.

Vernacular name. Akar engkarana (Iban, Sarawak)

Notes. This species is a host for *R. tuan-mudae*. In Peninsular Malaysia, this species is the commonest host of *R. cantleyi* and in Sabah this species is believed to be the host of Rafflesia found in Ranau. This species can climb up to 7 m tall. During fieldwork in Kumpang Linggir, Sri Aman it was observed that the fleshy part of the fruit was eaten by birds.

Selected specimens examined. BORNEO. Sarawak. Semantan, Mt. Pueh, Mixed dipterocarp forest, *WNF 33*, 8 November 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Lundu, Mt. Gading NP, Mixed dipterocarp forest, *WNF 40*, 13 October 2014, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Padawan, Tapak Rafflesia Kampung Temurang, Mixed dipterocarp forest, *WNF 44*, 10 November 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Padawan, Tapak Rafflesia Kampung Temurang, Mixed dipterocarp forest, *WNF 72*, 12 November 2014, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Semantan, Mt. Pueh, Mixed dipterocarp forest, *WNF 80, WNF 81*, 8 November 2015, W. N. Fatiha & M. Muklis (UNIMAS Herb.); Bintulu, Wilmar Plantation, Mixed dipterocarp forest, *WNF 90, WNF 91, WNF 92, WNF 93, WNF 94, WNF 97,* 23 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bintulu, Wilmar Plantation, Mixed dipterocarp forest, *WNF 95*, 24 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kuching, Kubah National Park, Mixed dipterocarp forest, *WNF 98, WNF 66, WNF 99,* 4 February 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kuching, Kubah National Park, Mixed dipterocarp forest, *WNF 99*, 3 February 2015 W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mt. Mulu National Park, Mixed dipterocarp forest, *WNF 100*, 48m; *WNF 105*, 45 m; *WNF 102*, 46m, 3 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Miri, Mulu National Park, Mixed dipterocarp forest, *WNF103*, 51 m, 5 September 2014, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Padawan, Tapak Rafflesia Kampung Temurang, Mixed dipterocarp forest, *WNF 172*, 5 April 2016 (UNIMAS Herb.); Sri Aman, Engkilili, Kumpang Langgir, Mixed dipterocarp forest, *WNF 1, WNF 7,* 29 January 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Engkilili, Kumpang Langgir, Mixed dipterocarp forest, *WNF 17*, 2 February 2016,W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Kapit, Pelagus resort, MDF, *WNF 18*, 10 April 2016,

W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Ulu Belaga, West of Sungai Tup, Ulu Sungai Danum, Primary mixed dipterocarp forest, *S. 81300*, 510 m, 18 August 1999, Julaihi et al. (SAR, SAN, MO, K, L, KEP); Samarahan Division, Sabal-Balai Ringin F.R., Logging area, Mixed dipterocarp forest, *S. 83593*, 221 m, 26 June 2000, L. C. J Julaihi et al. (SAR); Bintulu Division, Bukit Lumut, Submontane forest, *S. 65978*, 800 m, 24 September 1992, Abg. Mohtar & Yii P. C. (SAR, SAN, KEP, K, L); Limbang, 5th Division, Ulu Medamit, Long Amok Sg. Ensungei, Lowland forest near river bank area, *S. 43016*, 17 September 1980, Rena George et al. (SAR, L, K, KEP, SAN); Long Amok, Sg. Ensungei, Ulu Medamit, Limbang, 5th Division, Lowland Kerangas forest, *S. 43030*, 18 September 1980, Rena George et al. (SAR); Sri Aman, 2nd Division, Path to Mt. Silantek, Ulu Sg. Silantek Kiri, 85th Miles, Kerangas forests along ridge, *S. 42594*, 530 m, 27 August 1980 (SAR, CGE, L, K); Kuching, Lundu district, 1st Division, Mt. Gading, In mixed dipterocarp forest, *S. 35154,* 671 m, 24 September 1974, J. D. Mamit (SAR only); Belaga, bakun HEP, Sg. Berangan off Sg. Balui, Logged over mixed dipterocarp forest on ridge, A. Zainudin 5718, 510 m, 24 August 1995, A. Zainudin et al. (SAR); Bintulu, Tubau, Bukit Sekiwa, Mixed dipterocarp forest on foothill, *S. 52789*, 200 m, 26 August 1986, Abg. Mohtar et al. (SAR, K, L, KEP, SAN, MO); Simanggang, 2nd Division, Ulu Sg. Panabun, Tisak Sekarang, on river bank, *S. 45103*, 23 October 1982, Ilias Paie (SAR, K, L, KEP, SAN).

11. *Tetrastigma tetragynum* Planch.
in DC., Monog. Phan. 5, 2 (1887) 440; Suesseng. in Engler and Prantl, Natur. Pflanzenfam. ed. 2, 20d (1953) 326. *Vitis tetragyna* Miq., Ann. Mus. bot. Lugd. bat. 1 (1863-64) 78

Stem hollow, glabrous, longitudinally striate, 1.1-1.2 cm across, lenticels few, not prominent. Tendrils simple, 3.5 cm or longer, 1.22 mm across, glabrous. Leaves pedately 5-foliate, rarely 2-3-foliate, chartaceous, glabrous, the petioles 2.5-14.0 cm long, 1.1-1.5 mm across, few lenticels, less prominent, longitudinally striate; the stipules triangular, 0.2-0.5 cm long, 0.1-0.4 cm wide at base; terminal leaflets elliptic to obovate, 8.0-9.5 cm long, 4.8-5.5 cm wide, glabrous on both sides, the apex acuminate, the base attenuate, the margin serrate, primary venation 5-6 pairs, conspicuous above and below, raised, midrib becoming flatten above and below, secondary venation not prominent, the petiolules 2.5-5.2 cm long, lateral leaflets asymmetric elliptic to obovate, 6.6-7.5 cm long, 3.0-4.2 cm wide, the apex, base, margin, and nerves as in terminal leaflets, the petiolules 0.5-1.5 cm long, swollen at base with white growth ring. Inflorescence not observe. Berries red, 0.7 x 0.5 cm, 1-seeded, ellipsoid when dry, chalazal knot extending ¾ of the seed length, chalazal groove prominent.

Distribution. Borneo (Sarawak, Kalimantan), Sulawesi

Habitat. This species grows mostly on mixed dipterocarp forest at elevation from 38 m to 1050 m.

Vernacular name. Unknown

Notes. This species is reported to grow on basalt soil and associated with plant species of *Shorea, Knema, Lithocarpus* and *Artocarpus*.

Selected specimens examined. BORNEO. Sarawak, Mt. Mulu National Park, Along trail HQ, *WNF 104,* 38 m, 12 May 2015, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Sri Aman, Engkilili, Kumpang Langgir, Secondary mixed dipterocarp forest, *WNF 10,* 30 January 2016, W. N. Fatiha & S. N. Aishah (UNIMAS Herb.); Bario, Kelabit Highlands, beyond airstrip, ALM 4300, 1020 m, 14 April 1995, A. Latiff (SAR); West Kalimantan, Serawai, 8 km NE of Desa Jelundung, Batu Lintang1 Km south of camp along ridge, NSF 1444, 160 m, 24 January 1995, Church, A. C. & Mahyar, U. W. (SAR).

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